

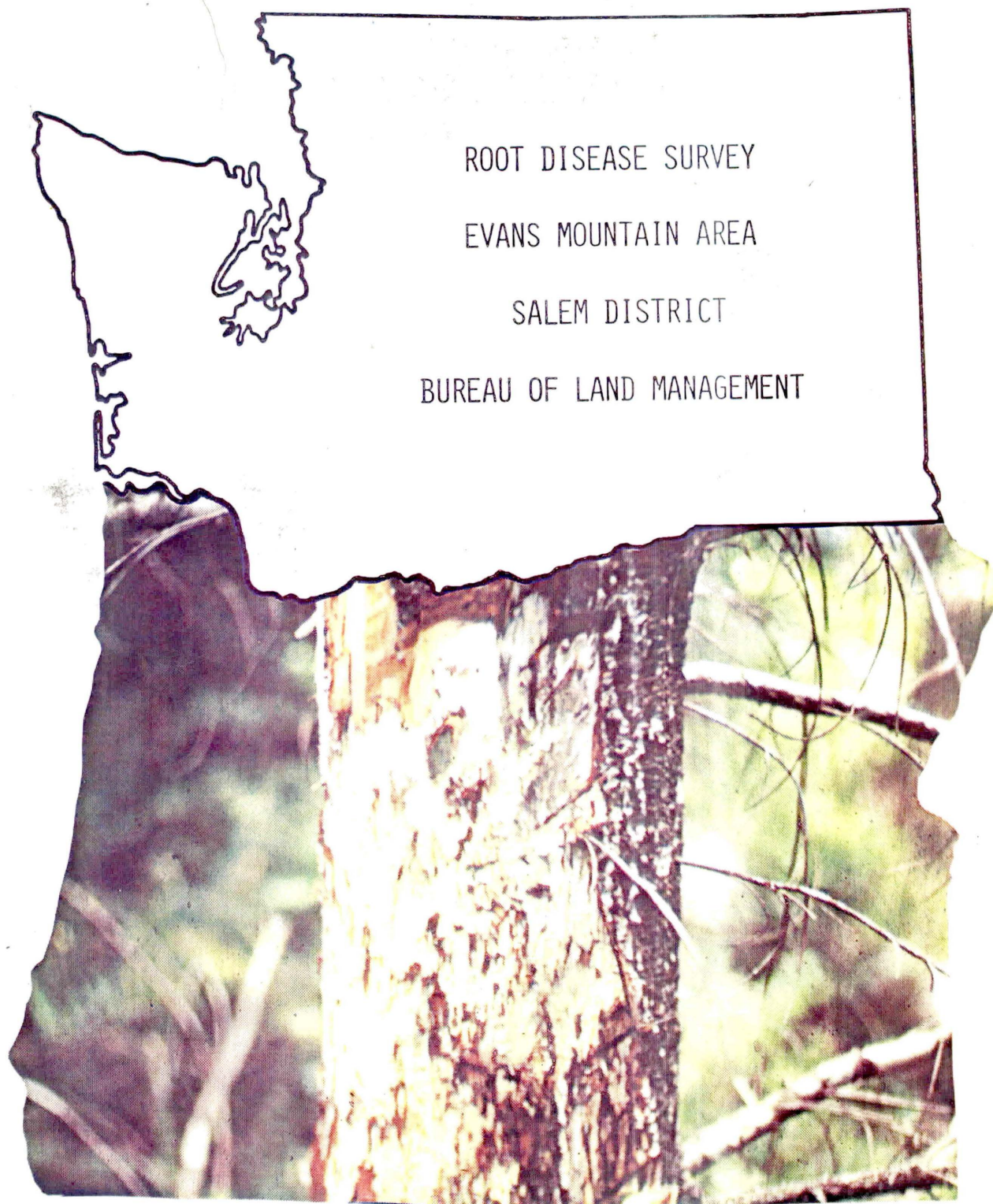
Forest Insect & Disease Management

Pacific Northwest Region

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ROOT DISEASE SURVEY

EVANS MOUNTAIN AREA

SALEM DISTRICT

BUREAU OF LAND MANAGEMENT

Root Disease Survey, Evans Mountain Area,
Salem District, Bureau of Land Management

by

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Appreciation is extended to Susan Byrd, Sally Cooley, Bruce Hostetler, Alan Kanaskie, and Dave Laws for assisting in this evaluation.

INTRODUCTION

During the weeks of April 27-May 8 and May 19-22, 1981, a root disease survey was done on Evans Mountain, Santiam Management Area, Salem District, Bureau of Land Management (T. 8 S., R. 4 E., sec. 19). Area personnel previously had noted high levels of Armillaria root rot (caused by *Armillaria mellea*) in plantations being considered for precommercial thinning in the locale. They requested an evaluation by a Forest Pest Management pathology crew to determine extent and severity of disease in the plantations and provide information on possible management ramifications.

METHODS

Stand Survey Technique--The 600 acres of plantations were divided into five blocks of approximately 120 acres each for ease of survey (figure 1). Each block was surveyed using a modified line-intercept method^{1/} with two independent grids of three lines each (six lines total per block). The interval between lines (grid interval) was determined by dividing the length of each block by the number of lines per grid (three). The grid interval was then multiplied by a three-digit random number (from a random number table) and divided by 1000. The first line was located at this distance from the corner of the unit and the other lines at the same intervals from each other. The process was repeated for the second grid.

All lines for blocks 1 and 2 ran north and south and for blocks 3, 4, and 5, east and west. A model M-25 hip-chain was used to measure line lengths and position of mortality centers.

^{1/} Bloomberg, Cumberbirch, and Wallis. 1980. A ground survey method for estimating loss caused by *Phellinus weirii* root rot. II. Survey procedures and data analysis. Canadian Forest Service, Pacific Forest Research Centre. BC-R-4, 44 p.

Two methods were used simultaneously to estimate infected area: the line method and the area method. With the line method, the proportion of total line length that fell within infected areas was determined (figure 2). With the area method, the proportion of a strip 30 feet wide (15 feet on each side of the line) that contained infected areas was determined (figure 2). With both methods, confidence intervals were established for each block by comparing results for the two grids.

Infected areas were determined on an individual tree basis (figure 2). This was done by estimating the rooting zone of a tree based on its DBH as follows:

<u>DBH (in.)</u>	<u>Rooting Zone (ft.²)</u>
1	22.1
2	34.9
3	50.6
4	69.3
5	90.8

Roots of infected trees were assumed to be 100 percent infected. Where groups of infected trees occurred with rooting areas overlapping, the diameter of the total rooting area was estimated by measuring outward from the trees at the margins. Frequently, if such a situation was extensive, the whole segment of line or length of strip could be recorded as infected (figure 2). When trees occurred outside of the strip but portions of their rooting zones fell inside, area of those portions also was recorded (figure 2).

In addition to root zone area, the following data were recorded for each infected tree or group of trees: (1) tree species, (2) root pathogen present, and (3) whether live, recently-killed (needles still present), or old mortality (no needles). Among live trees, only those with two of the following three symptoms were examined for root disease: (1) shortened leader, (2) foliage chlorosis, and (3) basal resinosis. Trees were examined by removing soil from the root collar and at least two major roots and checking bark surfaces for ectotrophic mycelia of *Phellinus weirii* (cause of laminated root rot), the bark-wood interface for mycelial fans of *Armillaria mellea* (cause of Armillaria root rot), and the sapwood for the dark stain of *Ceratocystis wageneri* (cause of black stain root disease).

Survey Maps--Rather than attempting to depict location of each disease center as determined from the survey, maps were constructed showing relative intensities of root disease (light, moderate, or heavy) based on number of individual disease centers near survey lines.

Monitoring Plots--In addition to the overall survey, four pairs of one-quarter acre plots were established to monitor effects over time of precommercial thinning on rate of root disease-caused mortality. Plots were located in areas of heavy stocking with high levels of root disease. The following data were recorded for each plot: (1) total count of all conifers >6 inches in height by species and tree condition (healthy, living but diseased, dead root diseased, dead not root diseased), (2) number of potential crop trees as marked on a 10x10 foot spacing, and (3) number, species, diameter, and condition (infected by pathogen or not infected) of all stumps from the former stand.

RESULTS AND DISCUSSION

Plantations surveyed were composed predominantly of Douglas-fir (*Pseudotsuga menziesii*) with some western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and western white pine (*Pinus monticola*). Douglas-fir had been planted in all surveyed blocks but natural seeding also had contributed substantially to stocking. Plantation ages ranged from 19 to 23 years. Examination of stumps revealed that before harvest the old stand was made up of western hemlock (50.6 percent) and Douglas-fir (49.4 percent).

Stocking levels differed among the blocks surveyed. Blocks 1, 2, and the southwestern portion of 5 were lightly stocked with scattered bare areas. Blocks 3, 4, and the northeast part of 5 were heavily stocked. Mean level of stocking in measured plots in the latter blocks was 931 trees per acre.

Armillaria root rot was the only root disease encountered in the plantations. It was found in all areas surveyed and was distributed as shown in figures 3-7. Both Douglas-firs and western hemlocks were infected. Intensity of the disease varied from block to block (table 1). Three blocks (1, 3, and 4) exhibited levels of infection that were very high for West Side forest plantations (2 percent or more of the land area contained in infection centers). In blocks with two percent or more of the land area affected, Armillaria root rot certainly should be of concern to managers.

Armillaria mellea is a common forest fungus that survives as a saprophyte in old stumps and roots. It can infect roots and root collars of nearby trees by growing across root grafts or contacts or by growing short distances through the soil. In most instances, *A. mellea* is a weak pathogen, affecting mainly injured or stressed trees. The high incidence of Armillaria root rot at Evans Mountain may be due to stress in the stands caused by soil slippage which is very dramatic in much of the area surveyed. Weather damage and animal feeding injury also are common. In addition, it is possible that a more virulent strain of *A. mellea* exists in the Evans Mountain area than in most West Side areas. The numerous large stumps from the former stand (mean 77 per acre) undoubtedly serve as effective inoculum reservoirs for the pathogen.

MANAGEMENT RECOMMENDATIONS

Basically, control of Armillaria root rot in established stands is done by promoting stand vigor and thus increasing tree resistance to the disease. Any management activity that contributes to increased strength of crop trees is beneficial. These would include thinning, fertilizing, animal damage control, competing vegetation control, erosion control, etc.

In West Side situations, it is believed that trees become increasingly resistant to Armillaria root rot with age. Observations indicate that most mortality caused by the disease occurs in stands before they reach the age of 30 years. Therefore, in the stands at Evans Mountain, the critical management concern is to minimize effects of the disease on stocking for the next 5 to 10 years. It should be borne in mind that many individual trees can die without adversely affecting stocking; the distribution of mortality is the important factor.

With the above considerations in mind, we make the following specific recommendations for the Evans Mountain plantations:

Block 1 - This plantation exhibits relatively high levels of Armillaria root rot but also is poorly stocked. We recommend that this stand not be thinned. If the District wishes to try to bring the stand up to a more desirable stocking level by planting some of the unstocked patches, we recommend using a species mix rather than Douglas-fir alone. Noble fir, western hemlock, and western white pine also could be planted. Finally, this unit showed evidence of severe mountain beaver (*Aplodontia rufa*) damage. Control of mountain beaver would contribute to disease control and should be considered.

Blocks 2 and 5 - These plantations have relatively little Armillaria root rot and can be managed in a normal fashion.

Blocks 3 and 4 - These plantations show relatively high levels of Armillaria root rot and are heavily stocked. We recommend that these units be thinned on a normal schedule, but to a somewhat closer than normal spacing (10x10 rather than 12x12 feet). We feel that such a thinning would increase leave-tree vigor and growth potential but, at the same time, not reduce tree numbers and spacing to such an extent that loss of some additional trees to root rot in the future would be disastrous. Forest Pest Management has established plots (described in methods) to monitor effects of thinning on root rot in both plantations and these will be followed for 20 years. Additional activities that might be applied in these units and would probably contribute to disease reduction would be mountain beaver control (especially in the draws and stream bottoms) and, possibly, fertilization.

Long term recommendations for disease reduction in the entire Evans Mountain area are:

- (1) Plan future harvests, road building, and other management activities in this area so that soil erosion and slope slippage are minimized.

- (2) In regenerating any unit in this area, plant only local seed source stock.

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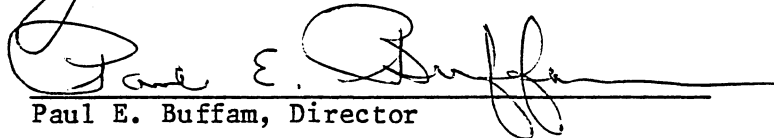
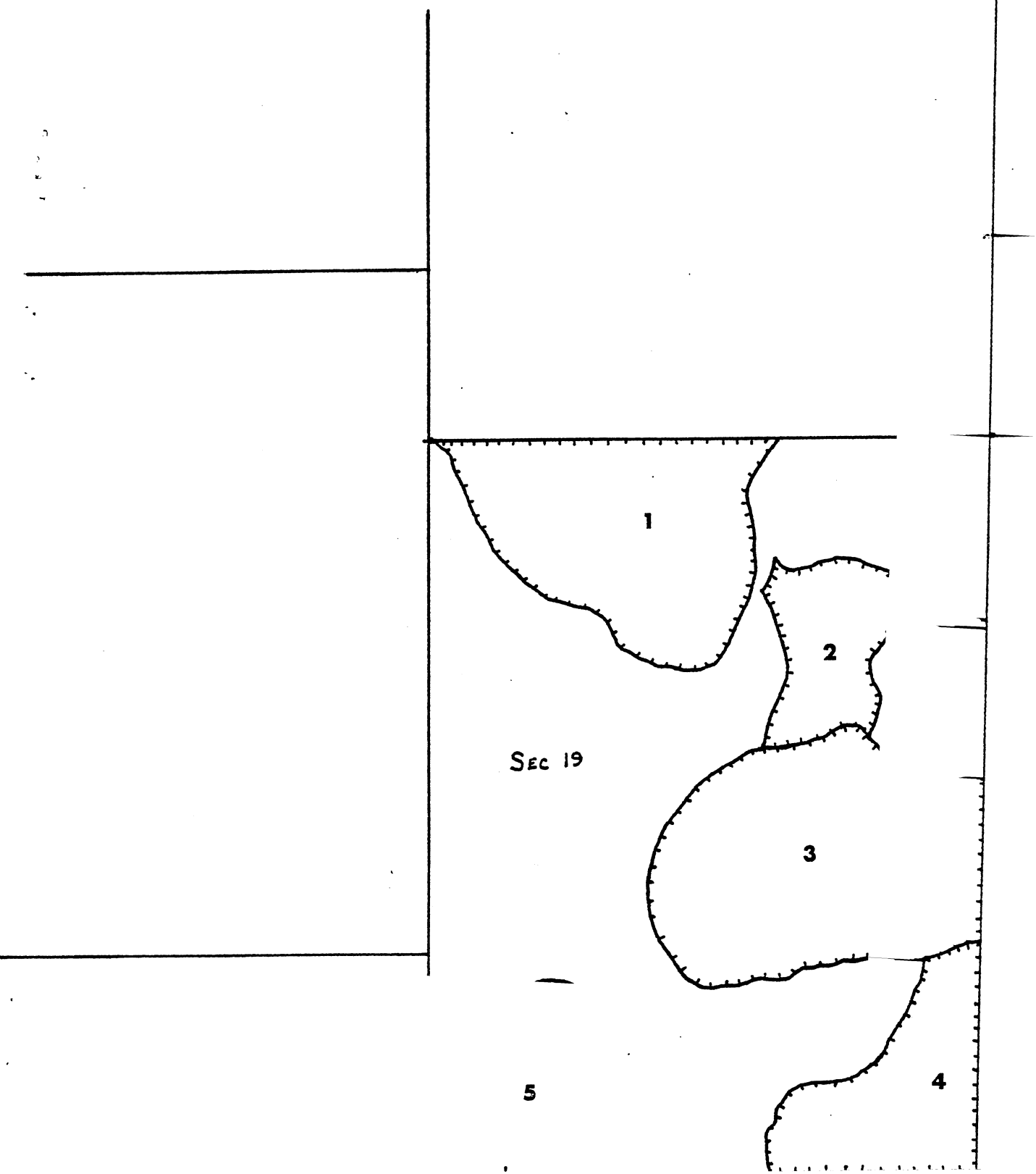

Paul E. Buffam, Director

Table 1: Areas affected by Armillaria root rot in Evans Mountain plantations
(data given are upper levels of confidence intervals, considered to
be best estimates with a scattered distribution).

Block Number	% of Total Area Affected	
	<u>Line Estimate</u>	<u>Strip Estimate</u>
1	2.1	2.6
2	0.6	1.2
3	2.4	2.2
4	2.0	1.4
5	0.7	0.5

Fig. 1 - Location of surveyed blocks in Evans Mountain area.



Legend
All Diseased Trees

- 1-9 Cluster of Trees
Entire line length a to b recorded.
Entire strip of same length by 30 foot width recorded.
- 10 Tree Outside Strip
Only unshaded portion of zone recorded. Zero line length.
- 11 Tree Near Survey Line
Line length a to b recorded.
Entire zone recorded.
- 12 Overtopped Tree
Zone not recorded.
Eclipsed by larger tree.
- 14 Trees Adjacent to Survey Line
Record entire zone.
Zero line length.
- 15 Tree Outside Strip
Zone not recorded.
Zero line length.
- 16 Tree Inside Strip
Only unshaded portion of zone recorded. Zero line length.
- 19 Small Cluster of Trees
Approximate diameter of zones determined and area recorded.
Zero line length.

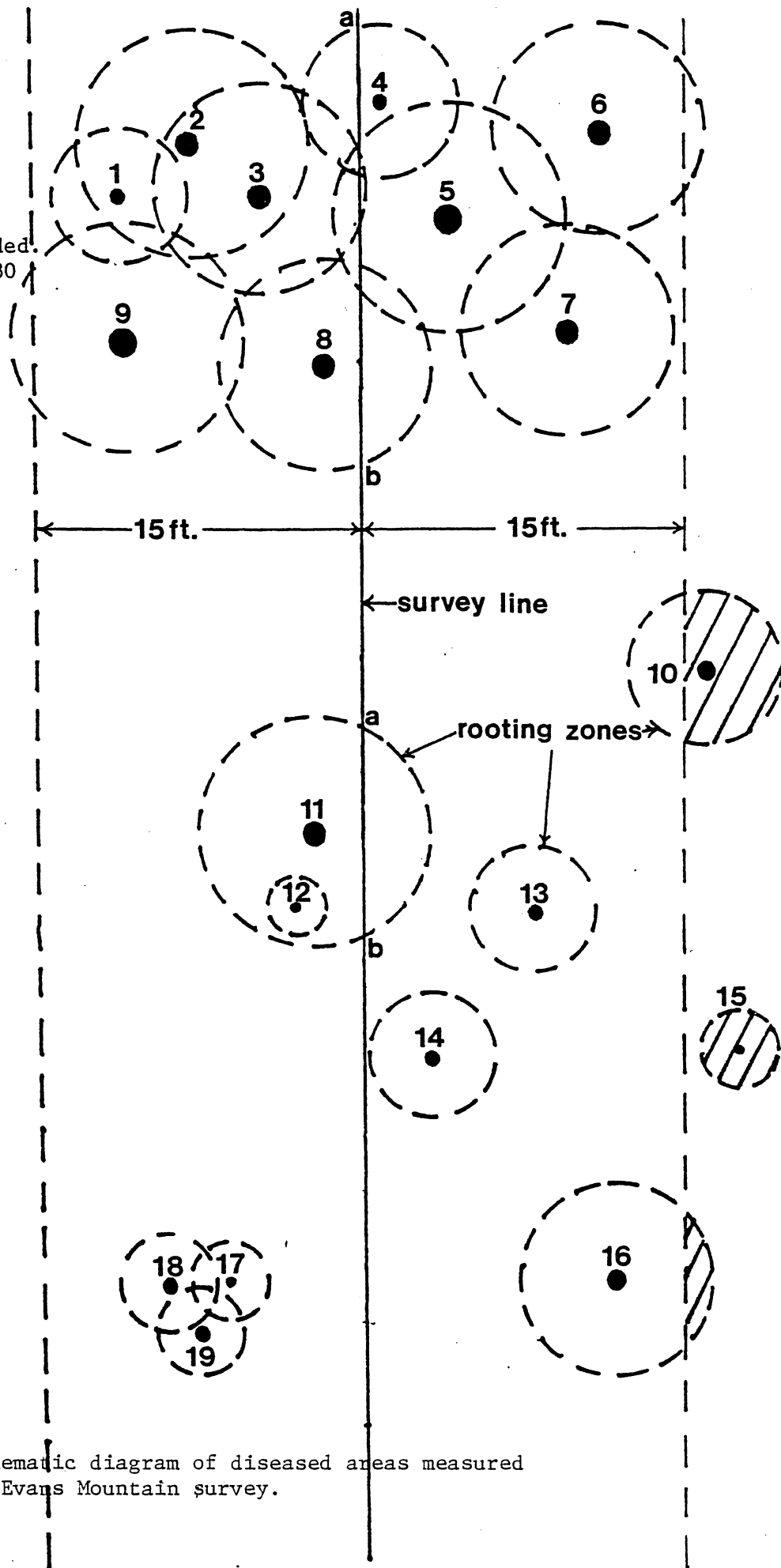


Fig. 2. Schematic diagram of diseased areas measured in Evans Mountain survey.

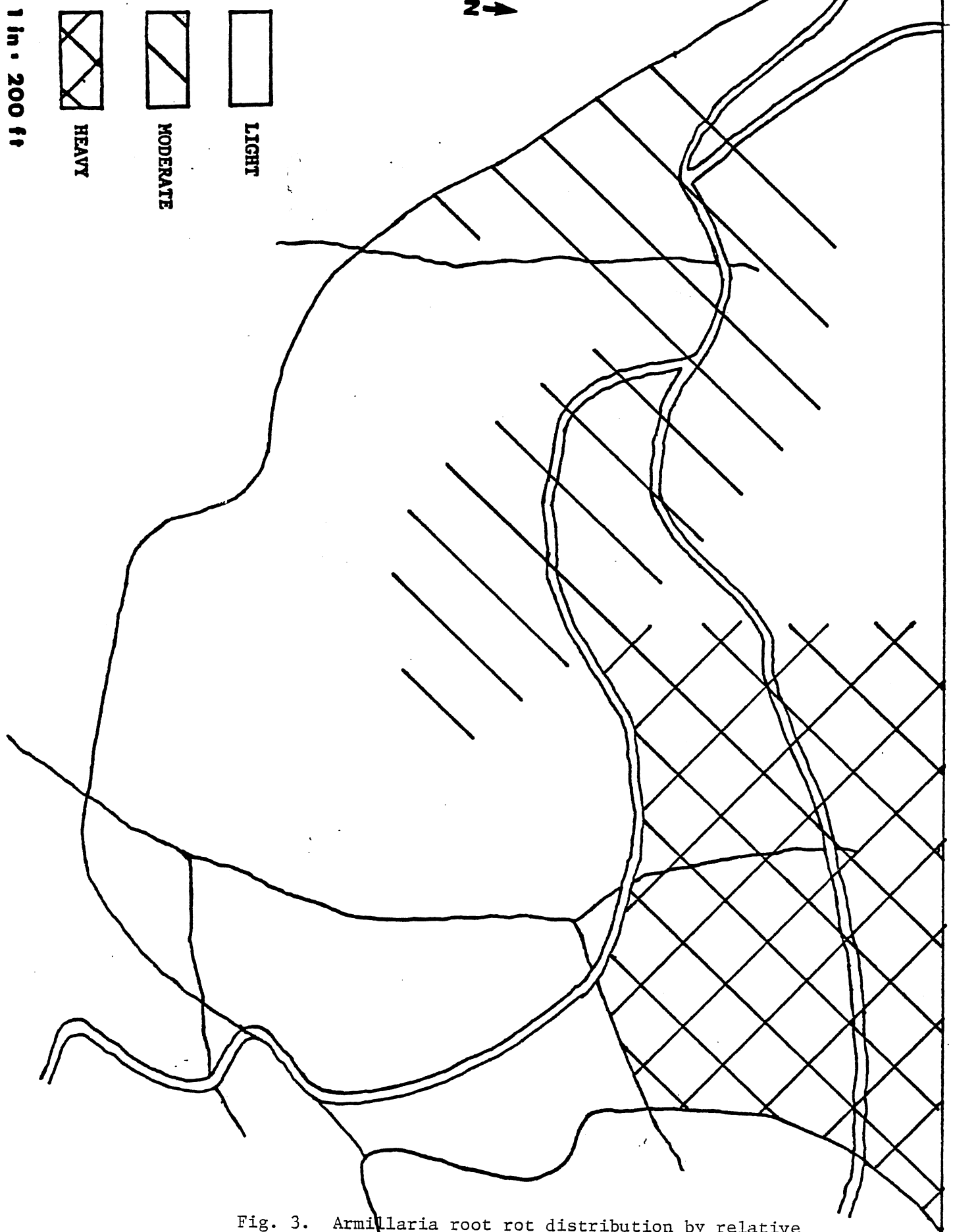


Fig. 3. Armillaria root rot distribution by relative intensity, block 1, Evans Mountain survey.

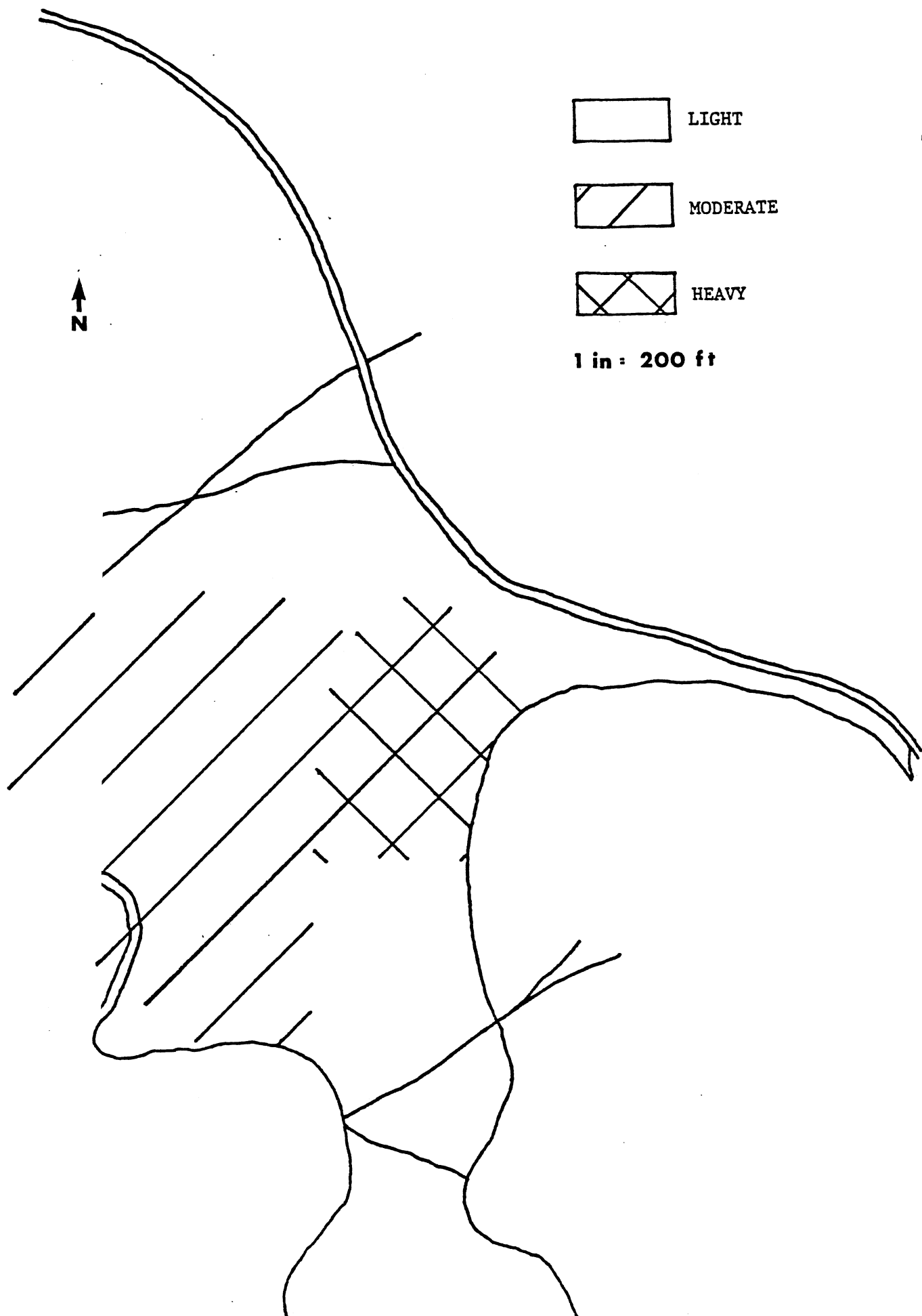
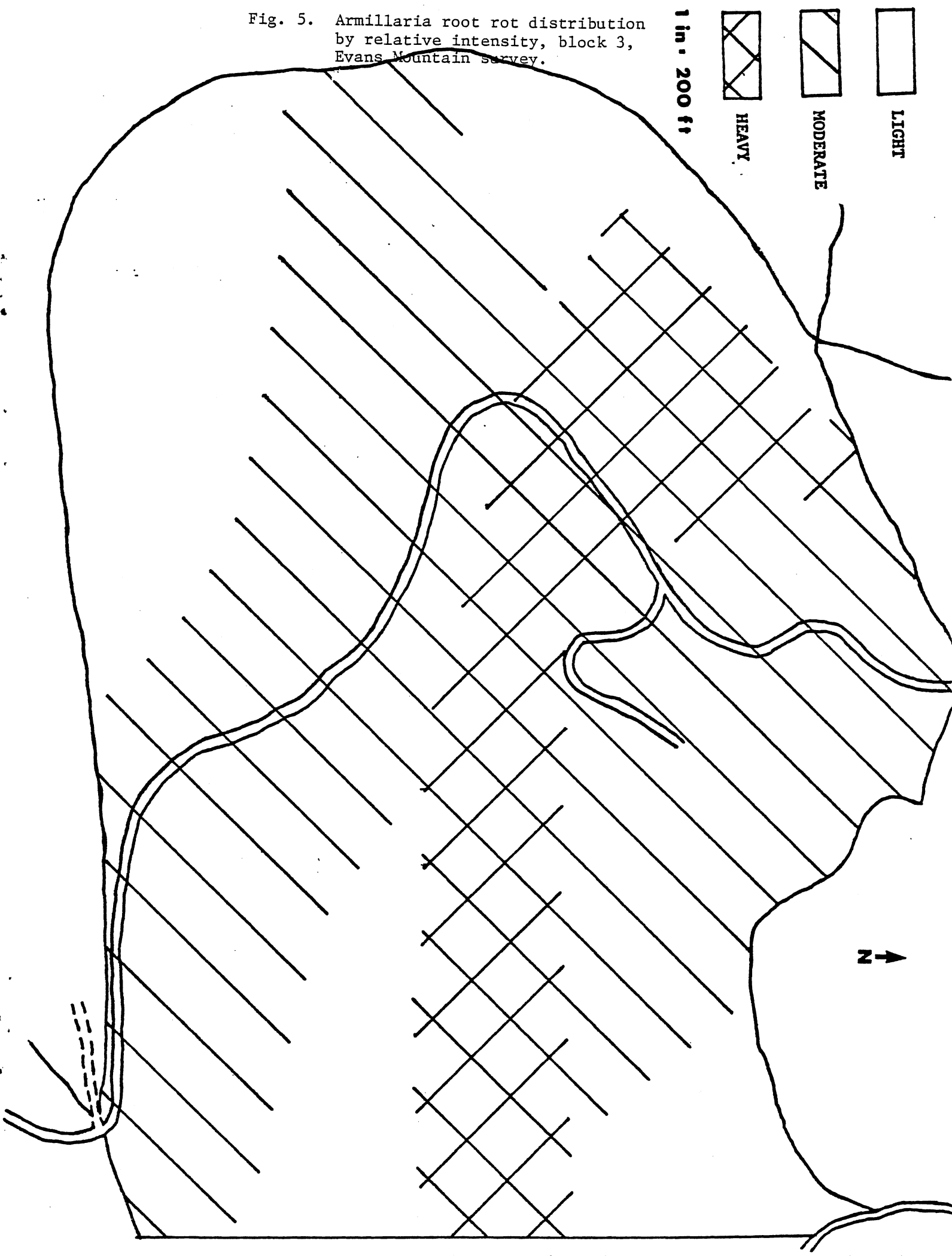


Fig. 4. Armillaria root rot distribution by relative intensity, block 2, Evans Mountain survey.

Fig. 5. Armillaria root rot distribution
by relative intensity, block 3,
Evans Mountain survey.



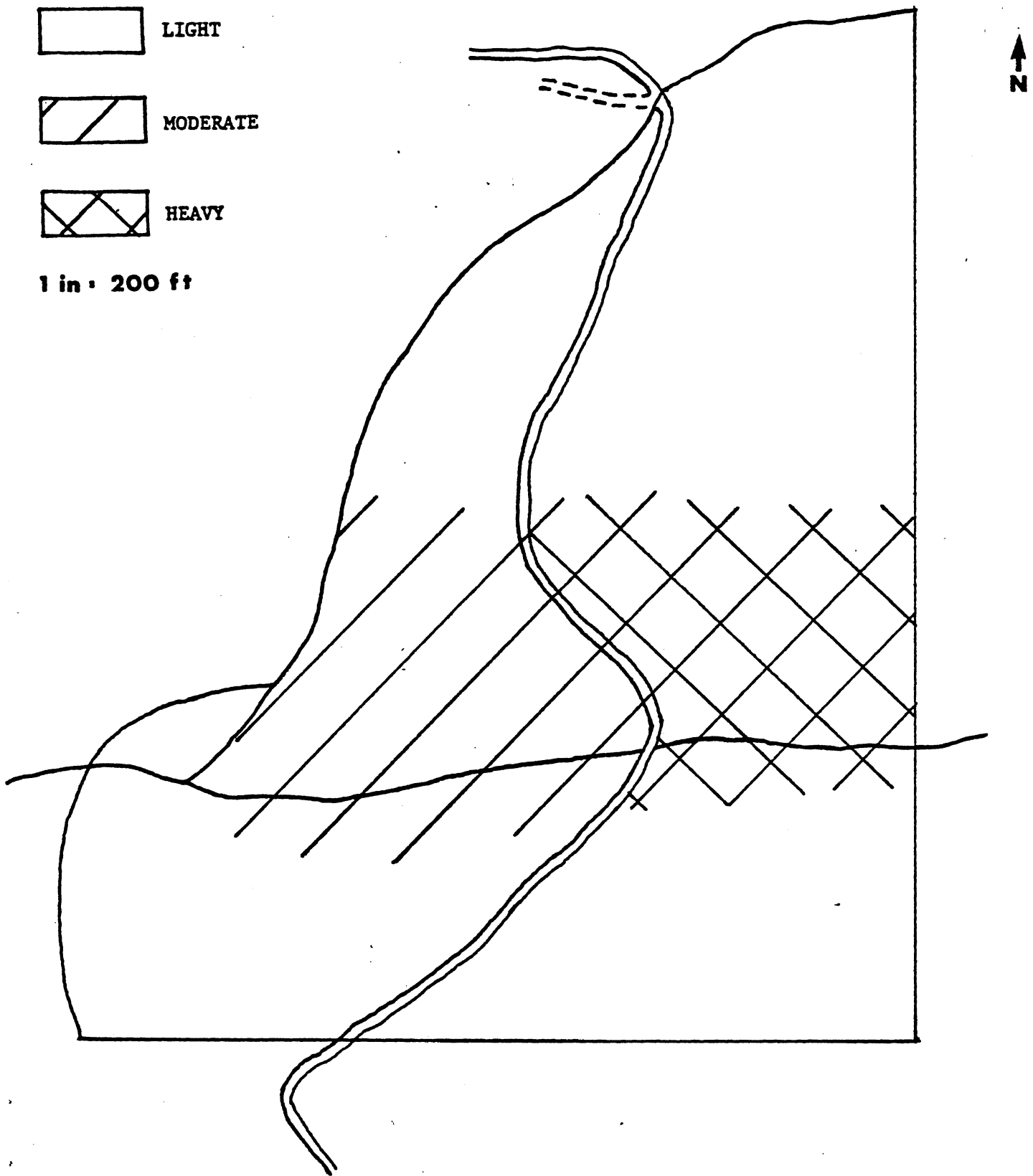


Fig. 6. Armillaria root rot distribution by relative intensity, block 4, Evans mountain survey.